STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

TRANSPORTATION RESEARCH DIVISION
BUREAU OF PLANNING

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ARAN/GIS VIDEO INTEGRATION

INTRODUCTION

The Maine Department of Transportation (MDOT) operates an Automatic Road ANalyzer (ARAN) to collect roadway information to make pavement quality assessments. Nearly 9000 miles of roadway data are collected by the ARAN in a two-year cycle. The ARAN has many Subsystems that collect data but the most widely used subsystem, by a variety of departments, is the Video Logging Subsystem. This Subsystem records Right of Way and Pavement data on high quality (S-VHS) videocassette tapes. Roadway features such as bridges, intersections, drainage, guardrail, utilities and pavement condition can be viewed using the videocassette tapes.

The problem is determining which videocassette tape represents the section of road you want to review. To clearly define the problem an explanation of how the data is logged will help. Each Route and Inventory Road is divided into sections called superlinks that range in length from two hundredths of a mile to nineteen miles. ARAN data is stored on S-VHS tapes and diskettes that are consecutively numbered in the field and data summary sheets are generated to document the corresponding videotape and diskette number for each superlink. The tapes, diskettes and summary sheets are stored in a library at the MDOT building in Augusta. Determining the correct videocassette tape representing a specific section of roadway is a time-consuming task. First you must determine the correct superlink number for the section of road you want to view by checking a map displaying all superlinks. Another necessary piece of information is to determine the beginning and ending Route Log Mile (RLM) for the section by accessing a program that contains distances to all roadway features along a route. Next you look through the ARAN summary sheets to find the correct tape and file number for that superlink. Then you retrieve the tape from the library, find an unoccupied video tape player, advance the tape to the correct section of roadway using the file number and RLM superimposed on the tape. This can take a considerable amount of time if you're unfamiliar with the ARAN file numbering system. The problem is that viewing a section of roadway using ARAN tapes is time consuming and difficult for those not familiar with the process, resulting in fewer people using the tapes than if the process was more efficient. Another potential problem exists when tapes are not returned to the library. The intent of this investigation is to simplify access to ARAN video images thereby increasing the use of this valuable source of information.

SCOPE

MDOT is implementing a Geographic Information System (GIS) into the department with the potential to link video images recorded by ARAN to the GIS base maps. Individuals capable of accessing GIS could select a section of roadway to view ARAN images of that section. This study will research the equipment and resources available to digitize and store ARAN images so a link can be created for GIS users to view them. Literature on this subject will be reviewed for methods and problems associated with collecting, storing and displaying roadway video information. Additional departments such as Construction, Environmental Services and others will be interviewed for input as to what roadway features they would like to view.

METHODOLOGY

The ARAN uses an array of equipment including gyroscopes, ultrasonic sonar, accelerometers, lasers and video cameras to collect roadway surface information. This information is stored on S-VHS videotapes and high volume disks. Data is collected continuously along the roadway then averaged and saved at 0.02-mile intervals called stations which the ARAN operator has the option of setting. Information collected by the ARAN includes rut depths, radius of curvature, grade and slope of the roadway, roughness and the video frame number at each station as well as continuous video of ROW, pavement and side view ROW.

ARAN data is compiled using the ARAN workstation, located at the main office in Augusta. The ARAN workstation uses frame numbers at each station to extract single frame images from videotapes and converting them to digital images. These images, as well as roadway data, can be saved on CD's or on a hard drive and referenced by a choice of parameters including route number, RLM, ARAN file number or frame number.

Maine DOT has a Transportation Information for Decision Enhancement (TIDE) system that is a powerful querying and reporting tool. TIDE combines data warehousing and GIS technology to provide users with an easy to use system for accessing, analyzing and reporting current and historical data.

TIDE uses two primary databases as its source: the department's Transportation Integrated Network Information System (TINIS) and Pavement Management System (PMS). PMS data contains ARAN surface measurement information. TIDE also incorporates a wide variety of spatial data that enables users to see and display data on a map and provides them with a powerful set of tools for spatial analysis through the use of GIS technology.

TIDE provides users with a wide-variety of querying functionality, including complete ad hoc capability, as well as pre-defined and established standard queries that can be invoked by the click of a mouse. Users can generate tables, reports, maps, or even pass results from the system to an external application such as a spreadsheet.

It is intended to link ARAN video to the TIDE data warehouse in an effort to display images of a section of road simply by creating a query of that section using TIDE.

ANALYSIS OF DATA

A request for literature produced papers concerning GIS and stationary video terminals but no information on incorporating video images into GIS. Because of this a questionnaire was sent to all states requesting information about displaying video images of the roadway on desktop PC's. Washington, Connecticut and Delaware responded.

Washington Department of Transportation collects video using a dedicated vehicle equipped with digital video cameras. Digital images are collected every one hundredth of a mile and stored on a hard drive in the vehicle. Images are then downloaded to storage units located in each of six divisions and an in house program is used to display the images.

Connecticut has been photo logging their roads since the seventies. They started out using film but the cost of film was to expensive so they moved to digitizing images on laser disk then transferring the images to CD's. They mentioned it would be better to digitize to CD's and skip the transfer from laser to CD. Connecticut uses Roadware products to record and display images.

Delaware is collecting and displaying roadway images in much the same manner as Connecticut.

A notice was sent to MDOT Division Heads, Division Engineers and Section Heads for feedback as to what features of the roadway a potential GIS user would like to see and how frequently they would like to view an image of the road for example 0.10, 0.05, 0.02 or 0.01 miles.

Some of the responses include:

Construction Division has an interest in viewing bridges, particularly guardrail and joints. Recording before and after videos of projects would be helpful in dealing with landowners.

The Office of Passenger Transportation is interested in viewing airport runway video collected in 0.1-mile increments.

The Office of Environmental Services is very interested and would like to use the video for permitting reviews, potential mitigation sites adjacent to highways, potential lake protection sites, roadside vegetation management program, scenic byways program, community gateways program, project team reviews, public meetings/hearings, interagency permit meetings and other reasons.

Computer Services at MDOT was concerned with the amount of memory necessary to store 9000 miles of images. Table 1 illustrates the amount of memory required for a variety of test intervals and file sizes.

According to Table 1 the normal data collection rate of the ARAN at one frame per 0.02 miles will consume 22.5 to 67.5 gigabits of memory depending on image file size.

Table 1

Memory Requirements

Test Miles	Test Interval (mi)	Number of Frames	JPEG file Size (K)	Storage Space (GB)
9000	0.01	900000	50	45.0
9000	0.02	450000	50	22.5
9000	0.03	300000	50	15.0
9000	0.04	225000	50	11.3
9000	0.05	180000	50	9.0
9000	0.01	900000	75	67.5
9000	0.02	450000	75	33.8
9000	0.03	300000	75	22.5
9000	0.04	225000	75	16.9
9000	0.05	180000	75	13.5
9000	0.01	900000	100	90.0
9000	0.02	450000	100	45.0
9000	0.03	300000	100	30.0
9000	0.04	225000	100	22.5
9000	0.05	180000	100	18.0
9000	0.01	900000	125	112.5
9000	0.02	450000	125	56.3
9000	0.03	300000	125	37.5
9000	0.04	225000	125	28.1
9000	0.05	180000	125	22.5
9000	0.01	900000	150	135.0
9000	0.02	450000	150	67.5
9000	0.03	300000	150	45.0
9000	0.04	225000	150	33.8
9000	0.05	180000	150	27.0

Videocassettes are processed using the Video Editor program at the ARAN workstation. Steps involved to process a videocassette include generating a file containing frame numbers for each station from ARAN data files. Then frames for each station are extracted from the videotape and stored on a Perception Drive. Next frames from the Perception Drive are converted to JPEG images and moved to a storage location.

Image file size is directly related to image quality. Two options, Block Limit and Compression Quality, selected before processing ARAN videocassettes determine image quality.

Block Limit directly influences the Perception Drives compression ratio, which affects video quality and processing speed. Block Limit is set from 100 to 500. When the number is increased the image quality is increased and processing speed is decreased.

Compression Quality also affects image quality and processing speed when converting images from the Perception Drive to JPEG images. This setting is between 20 and 100. When the ratio is increased the image quality is increased and processing speed is decreased. Figures 1 and 2 illustrate image quality based on Block Limit and Compression Quality settings.

As illustrated in Figure 1, Block Limits were set at 100, 200, 300, 400 and 500 with a Compression Quality of 100 for each image. Block Limits set at the 100 and 200 range are fuzzy and dull. Limits set at 300, 400 and 500 are very similar in quality. The default Block Limit setting is 320; this results in a high quality image at a processing speed that is effective.

Figure 2 illustrates the effect Compression Quality has on the images. Images were extracted from the videotapes to the Perception Drive with a Block Limit setting of 500 and Compression Quality settings of 20, 40, 60, 80 and 100. Compression Quality settings of 20, 40 and 60 are dull and less defined. Settings of 80 and 100 show a sharp contrast between the yellow stripe and pavement plus cracks are more defined.

Figure 3 illustrates the effect Block Limit and Compression Quality settings have on image size. Block Limit does not seem to affect file size as severely as Compression Quality appears to. It seems that the default Block Limit of 320 and a Compression Quality setting of between 80 and 90 would produce a sharp image capable of clearly displaying most roadway features at a file size that wouldn’t take up much memory and would display more readily on your desktop PC.

CONCLUSIONS

At the beginning of this study computer memory was a costly commodity and image file size was a concern. Today, computer memory is in abundance and coprocessors are much faster consequently image file size is of little concern and additional images such as airport runways and bridges could be displayed.

Interest and input from a variety of divisions has changed this project from a study of how to conveniently access ARAN video to the development of Imager, a stand-alone program developed by Keith Fougere of the Pavement Management Systems unit and Nancy Armentrout of the Information Systems Development unit. Imager is designed to display ARAN right-of-way videos and is very simple to operate; the first step is to determine the Route number and RLM of a section of roadway by using TIDE. Next Imager prompts the user for TIDE Map Selection, TIDE Query Results or User Entry as in Figure 4. Currently the only option available is User Entry. The user enters the Route number, Beginning RLM and Ending RLM to start the program, see Figure 5. Figure 6 illustrates Imager displaying a portion of Route 4 in South Berwick at the north junction of Route 236. Imager is capable of displaying one image at a time or pages through the images using a frame delay setting that can be adjusted by the user. Additional information including Link ID number, County, division number, jurisdiction, National Highway System status, Federal Functional Classification, Federal Urban or Rural Classification, street name, Factored AADT, speed limit, left and right shoulder widths, number of lanes, through lane width, Pavement Condition Rating (0 - 5), left and right rut depths and roughness (IRI) are also displayed.

Images of roughly half the state have been processed from analog tapes. ARAN videotapes are processed at the ARAN workstation. Two two-hour tapes can be processed per day. When ARAN tapes are processed the workstation cannot be used to process other data. Because of this, MDOT is in the process of updating the ARAN Video Subsystem to collect images in digital rather than analog format. Digital images will be recorded in JPEG format to a removable hard drive. The hard drive can then be removed from the ARAN and uploaded to the network, eliminating the need to process videotapes and allow users to process additional ARAN data.

As mentioned earlier Imager is currently a stand-alone program. Future versions of Imager will be linked to TIDE directly, enabling a TIDE user to select or highlight a section of roadway and have the option of displaying images of that section.

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Figure 1.
Block Limit Settings

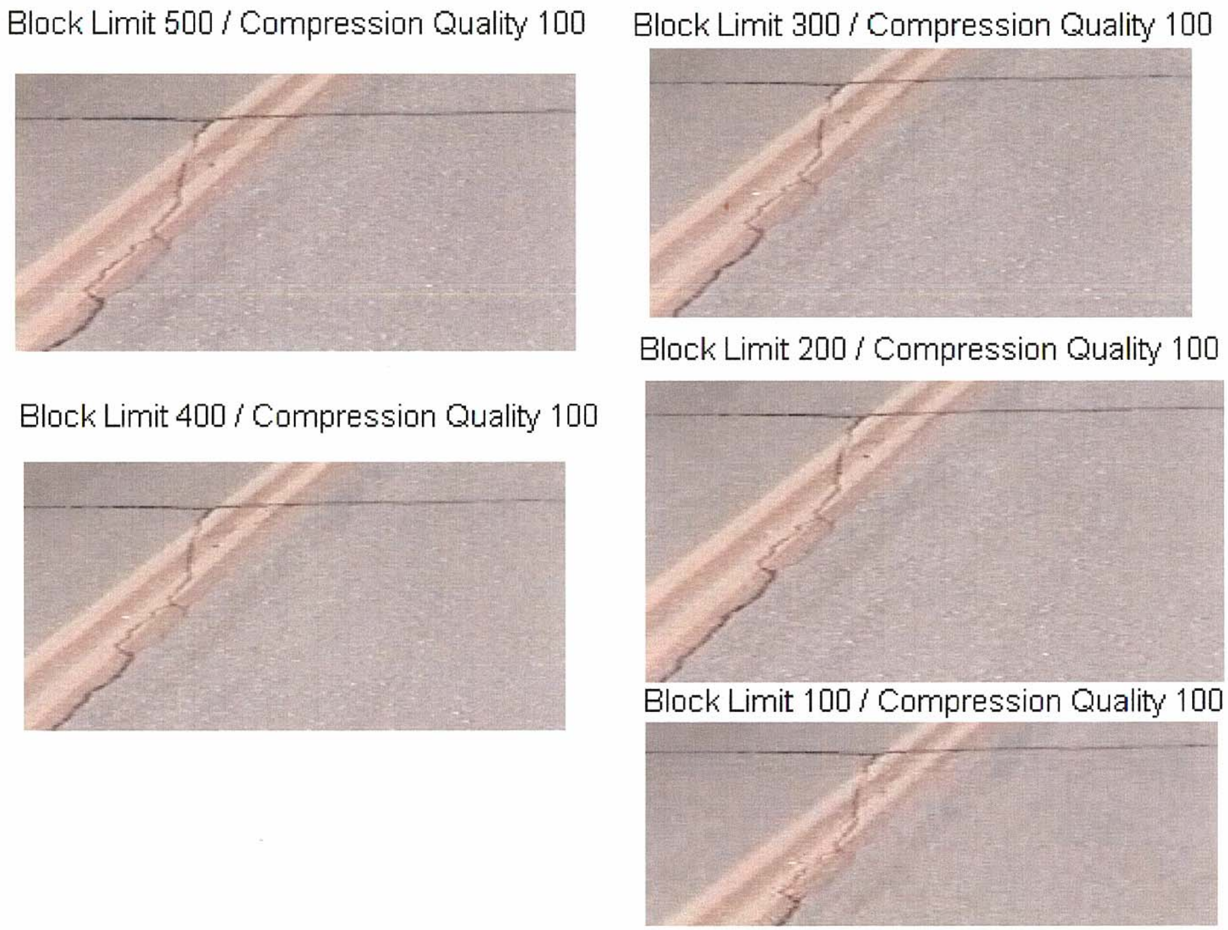

Figure 2.
Compression Quality Settings

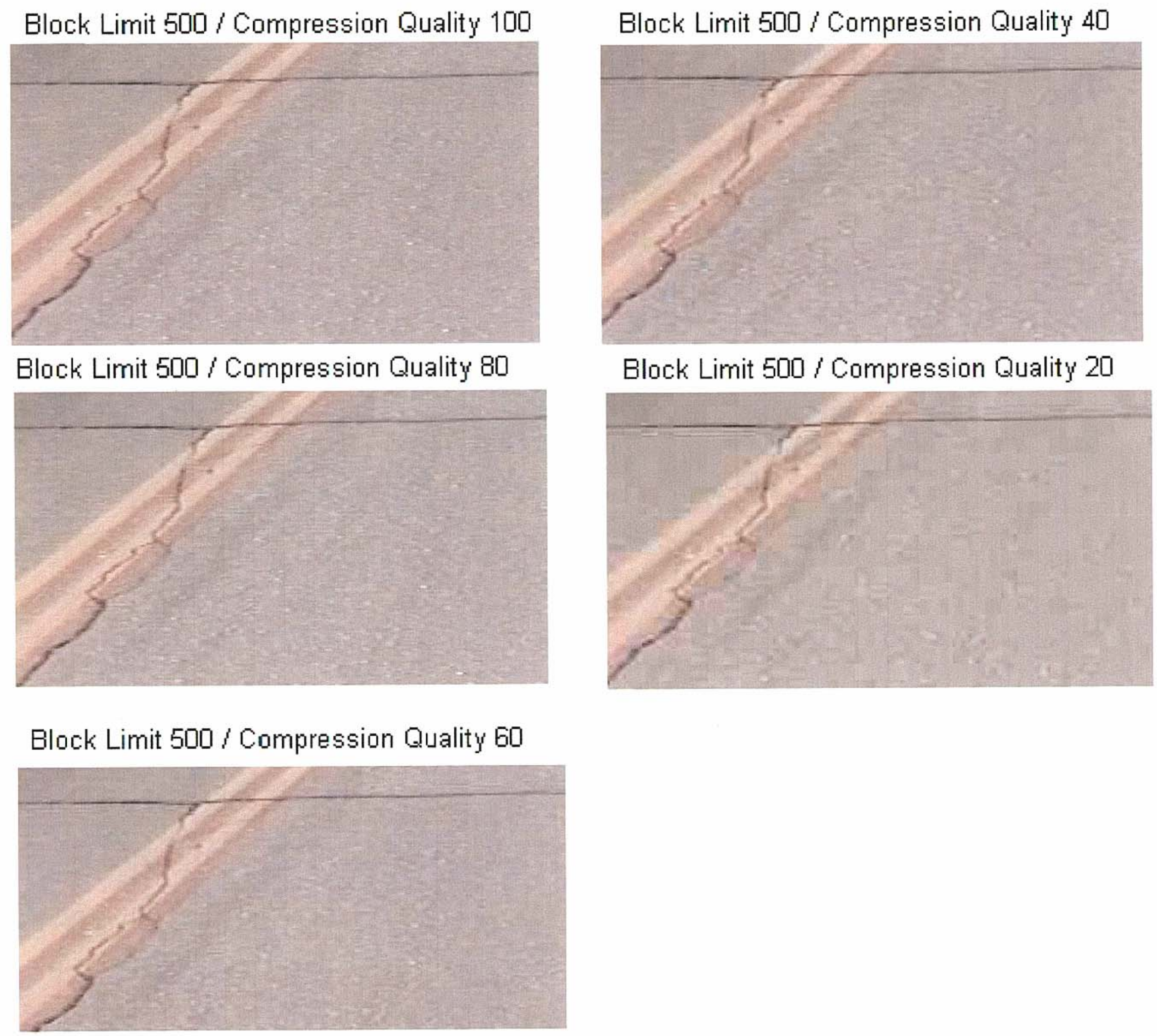

Figure 3.
Image File Size Graph

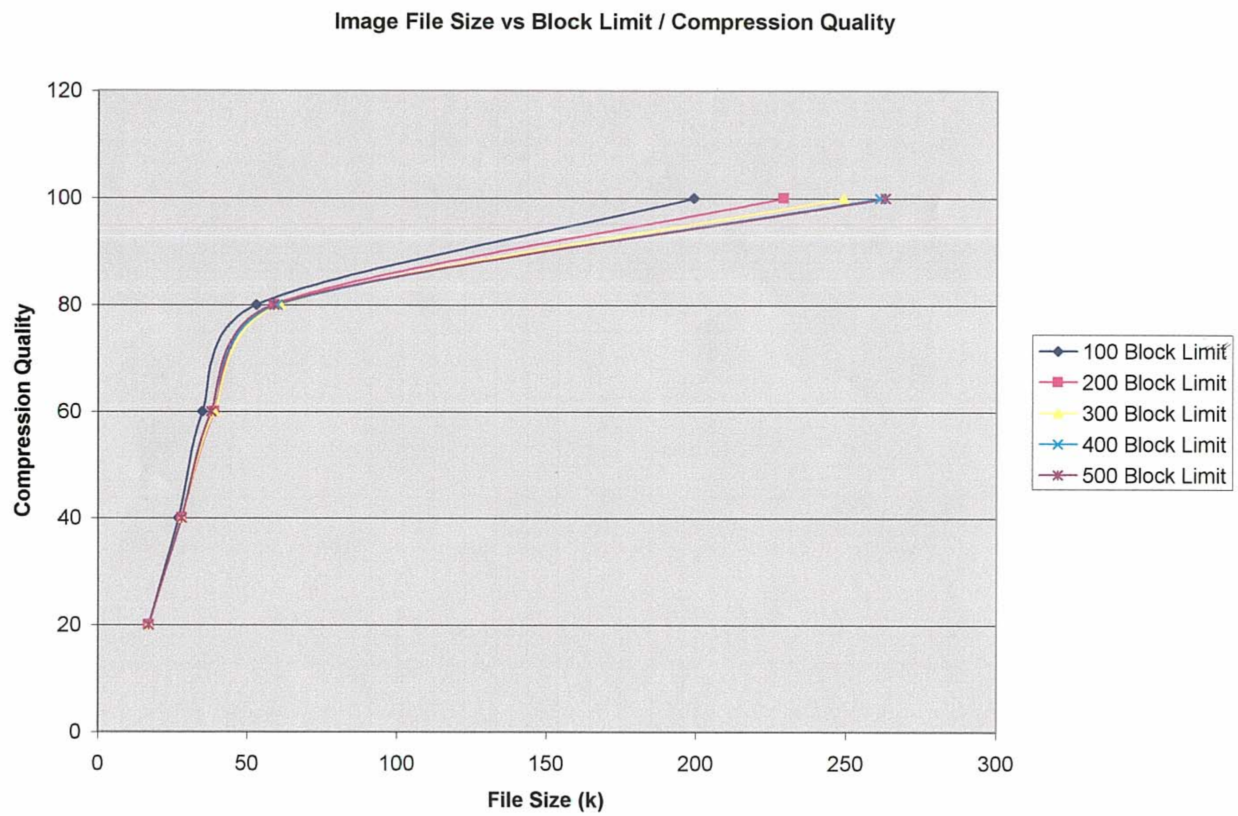

Figure 4.
First Imager Screen

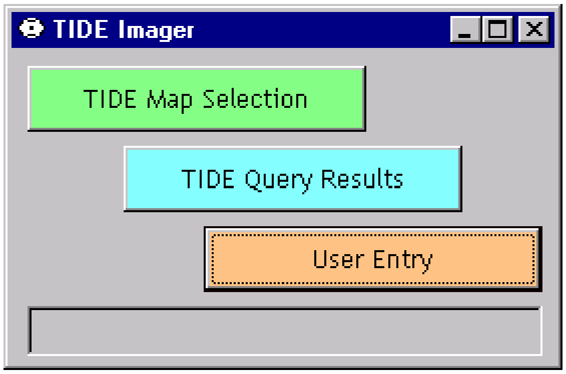

Figure 5.
Second Imager Screen

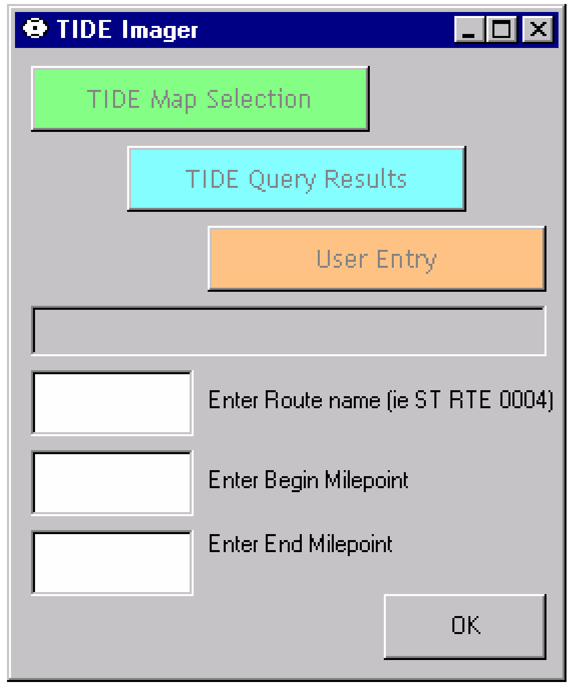

Figure 6.
Imager Display Screen